AAS22-P01 Room:Convention Hall Time:May 20 18:15-19:30

ENSO-induced changes in the Northern winter stratosphere revisited

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Using the JRA-25/JCDAS reanalysis and JMA hindcast (HC) data, this study re-examines the ENSO-induced changes in the Northern winter stratosphere.

This study seeks to better understand the observed changes in the time mean states and variability (such as occurrence of stratospheric sudden warmings, or SSWs): it is widely accepted that the polar vortex is weaker and warmer on average for warm ENSO years than for cold years, whereas occurrence of highly disturbed situations of the vortex such as SSWs is more frequent (or as frequent) for cold ENSO years. For this purpose, we utilize the reanalysis and also the HC data. The HC experiments were conducted by the JMA using March, 2011 version of the 1-month ensemble prediction system. The ensemble predictions were made from each of the 10th, 20th, and last day of each month for 1979-2009, with an ensemble size of five.

In the analysis data (real world), we first confirm the existing results that the polar vortex changes in the time mean states and variability with ENSO. Then, we find that the frequent occurrence of disturbed situations for cold ENSO years is mainly contributed by a couple of SSWs (e.g., those in 1984/85 and 2005/06 winters). These SSWs occur with moderate upward propagation and marked poleward propagation of wave activity under the easterly condition of the QBO.

In the HC data, we further show that, when initialized about 10 to 20 days before the SSWs, the data only roughly reproduce such propagation features and underestimate (or miss) the deceleration of the polar night jet. These features of the wave propagation are therefore the key for the HC data to well reproduce the SSWs, and hence the ENSO induced changes in the stratospheric variability as observed.

Keywords: stratosphere, ENSO-induced changes, stratospheric sudden warming, QBO

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Observation of aerosol profiles using balloon separated Unmanned Arial Vehicle at Syowa Station, East Antarctica

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Boundary regions in the upper atmosphere play important roles in the global budget of material and energy. It is difficult to perform in-situ observations and sample recovery in/from the regions. There are some platforms for them, airplane, balloon, rocket and so on. They require heavy loads and/or cost for observations.

Small Unmanned Aerial Vehicle (UAV) is one of the most cheap and mobile platforms. Recent developments of electronic devices, microcomputer, and navigation system have been drastic and it supports to develop many types of small UAV. On the other hand, a small rubber balloon is very cheap and useful to lift instruments to upper atmosphere. We started to develop new type of platform, combined a balloon and an UAV. In the first stage, an UAV is hanged and lifted by a rubber balloon to the stratosphere. Aerosol instruments borne in UAV observe aerosol concentration and collect sample during ascending. At the top altitude, planned to separate position, UAV cut hanging rope and return to ground base with instruments and sample by self-control with micro-computer system.

We performed aerosol observations upto 10 km a.s.l. at Syowa Station (69.0 oS, 39.6 oE) in January 2013, as one program of the 54th Japanese Antarctic Research Expedition. Five successful flight were carried out and observe vertical profiles of aerosol concentration ranging from 0.3 to 11.4 um in diameter, and collect sample up to 8 km a.s.l.. Tropopause is locate around 8 to 10 km a.s.l over Syowa Station in summer season.

We are planning to develop more advanced platform, using balloon, parachute, and UAV, which can realize observation up to 30 km.

We will report details of the developed new type of platform and preliminary results of aerosol observations at Syowa Station.

Keywords: balloon seperated UAV, stratospheric aerosol, Antarctica

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Updates of JEM/SMILES L2Product v2.4: improvements of mesospheric O3 and HCl profiles

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The SMILES (Superconducting Submillimeter-Wave Limb-Emission Sounder) , an instrument for a joint mission of Japan Aerospace Exploration Agency and National Institute of Information and Communications Technology, had observed atmospheric submillimeter spectra from 2009/10/12 to 2010/4/21 from the International Space Station (ISS). The SMILES has 4K-cooled superconducting mixers and had performed the observation with high sensitivity and stability. Standard L2 products are O3 and some molecules related O3 chemistry, such as HCl, ClO, HNO3, CH3CN, HOCl, HO2, BrO and O3-isotopes (17OOO, O17OO, 18OOO) and v2.1 are released for non-limited users in spring, 2012. About O3, the most sensitive SMILES product, validation study with comparing other satellite data and numerical modes is already advanced [Imai et al., 2012, submitted to JGR]. Additionally, ISS, attached SMILES, has a solar asynchronous orbit and SMILES data are used diurnal variation studies [e.g. Sakazaki et al., 2013, JGR].

Latest L2 Product v2.4 is scheduled to be released in spring, 2013. It is a one of the goals of updates after v2.1 to improve upper mesospheric profiles.

In v2.1, the recommended altitude range of O3 for scientific use is 16 - 73 km since profiles vibrate in upper altitude range. It is because retrieval settings are not suitable. A priori profile of O3 is monthly climatology based on AURA/MLS v2.2 for 2005-2007. However, a priori profile above 75 km is not suitable since it is outside of useful altitude range. In v2.4, retrieval altitude range is expanded up to 120 km, and a prior profile and error are adjusted. As a result, noise in the mesosphere is reduced, and SMILES profiles has sub-peak in upper mesosphere which is observed by other satellite like SABER [Smith et al., 2013, submitted to JGR].

In HCl case, retrieval altitude range was expanded up to 100 km like O3. Additionally, about 2% of vibration near 50 km is suppressed. There are 2 factors. One is to revise AOS response function which is one of instrument functions by SMILES instrument team. Accuracy of signal extraction was improved by changing analysis method and vibration of HCl was reduced to 1 %. The other is to update inversion algorithm. Although optimal estimation method was used, Tikhonov reguralization method was also newly added. Thereby, HCl profiles become smooth.

Keywords: SMILES, JEM, Ozone, mesosphere, ISS

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Analysis of Arctic stratospheric minor gases related to ozone depletion by coupled use of JEM/SMILES and ACE-FTS

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The Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) is a sensor equipped in the Japanese Experiment Module "KIBO" on board the International Space Station (ISS), which has unprecedented high sensitivity with superconducting technology. SMILES had observed atmospheric minor constituents which included ClO which was not able to be observed by high sensitivity until now in the stratosphere and mesosphere from October 12, 2009 to April 21, 2010 with more than ten times the precision of other existing sensors. The Atmospheric Chemistry Experiment - Fourier Transform Spectrometer (ACE-FTS), which is on board SCISAT-1, has been observing atmospheric minor constituents in the upper troposphere and stratosphere from March 11, 2004 by solar occultation technique. We have analyzed SMILES Level 2 (L2) research products and ACE-FTS to discuss the relationship between temperature and stratospheric minor gases related to ozone depletion and time variation of Cl Partitioning in the Arctic winter of 2009/2010.

Analysis of the SMILES L2r ClO profile and the ACE-FTS HCl, NOy, ClONO2 and N2O profiles from 50 to 65N showed that differences in ClO, HCl and ClONO2 concentrations between inner polar vortex and outer polar vortex was the largest from 18 to 28 km in January and February 2010. We calculated ice frost point (Tice) at each measurement location. In the region where a temperature was lower than the calculated Tice plus 15 K, concentrations of HCl, ClONO2 and NOy dramatically decreased; decrease in the concentrations was the largest at equivalent latitudes higher than 70. It is suggested that the decrease in HCl, ClONO2 and NOy was caused by PSC formation and heterogeneous reaction on the surface. We analyzed correlations between N2O and other minor constituents. A compact correlation between them was seen in November 2009. On the other hand, the correlation in January and February had a different characteristic. This suggests that changes in concentrations of these minor constituents was caused by chemical factors, not by dynamical factors. We analyzed a time-series of Cl Partitioning by using ClO and HOCl observed by SMILES and HCl and ClONO2 observed by ACE-FTS in inner polar vortex in 2009/2010. The concentrations did not change in November 2009. In the beginning of January 2010, the concentrations of HCl and ClONO2 decreased. In the middle of January, the concentration of ClO dramatically increased. In the end of January, the concentration of ClO dramatically decreased and the concentrations of HCl and ClONO2 increased. In February and March, the concentration of ClONO2 was higher than that in November 2009. In the presentation, we show more detailed analysis of Cl Partitioning in 2009/2010 observed by SMILES and ACE-FTS.

Keywords: startospheric minor gases, ozone depletion, remote sensing

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Correlation among water vapor and ozone as observed from Aura/MLS

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We present a relationship between water vapor mixing ratio (WV) and ozone mixing ratio (O3) measured by Aura/MLS in the tropical upper troposphere and lower stratosphere during 2005-10. Seasonal variability is analyzed in WV and O3 using MLS data. During summer (April-September) WV and O3 scatter plots are used to examine the relationship between them at different pressure levels. Around 100 hPa and above, it seems that there is an increasing linear tendency between WV and O3 with a high correlation coefficient. However, during winter (October-March) it seems that there is an association between WV and O3 but comparatively lesser than summer. From the scatter plots of WV and O3, it appears that during convection WV is injected from troposphere to lower stratosphere in the tropical region. However, the increasing amount of O3 and WV just above tropopause appears that it is dynamically controlled during summer. The O3 values are in general high during summer as compared to winter and are larger by a factor of ˜2 while at 68hPa WV values are high during winter by a factor ˜1-2. The temperature during summer show high values as compared to winter above tropopause. Our analysis suggests that there is a need to study jointly O3 and WV that would help in better understanding the transport in the TTL region and above.

Keywords: Tropical Tropopause Layer, Water Vapor, Ozone

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Validation of ozone and chlorine compounds data observed by SMILES

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The Superconducting Sub-millimeter Limb-emission Sounder (SMILES) onboard Japan Experiment Module (JEM) of the International Space Station (ISS) have observed atmospheric minor constituents related with ozone chemistry, such as O_3, HCl, ClO, HO_2, HOCl and BrO, with high sensitivity. Especially, O_3, HCl and ClO can be detected with altitude up to the mesosphere (around 80km). In comparison with the stratosphere, "in situ" photochemistry controls concentration of minor constituents, so that we can examine current understanding of whole atmospheric chemical reactions by the direct comparison with SMILES observational data and results from numerical model calculations. In this study, we report the characteristics of ozone and chlorine compounds in stratosphere and mesosphere observed with SMILES instrument. Some results of comparative validation with past satellite data and numerical model calculations, and their characterisics of diurnal variation are also presented.

Keywords: stratosphere, mesosphere, diurnal variation, ozone, limb sounding, submillimeter wave

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Characteristic of Vertical Wavenumber Spectra in The Lower Stratosphere Observed with COSMIC GPS Radio Occultation

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Vertical wavenumber spectra of atmospheric temperature perturbations in the lower stratosphere were analyzed by using COSMIC GPS Radio Occultation data. This study used high resolution profiles from January 2007 to December 2009 derived from the Full Spectrum Inversion retrieval method (Tsuda, et.al., 2011). The height range between 20 to 27 km was selected considering the atmospheric conditions are relatively stable over the entire latitude range. We investigated latitude variations of spectra over two longitude regions; 90 to 150 and 170 to 230 degree east, considering land and ocean distributions. The logarithmic spectral slope of temperature perturbations in the equator region agrees with the model spectrum throughout the year showing saturated gravity wave due to convective activity. It has been depicted an annual variation in the spectral slope at mid latitude in northern hemisphere, which is close to -3 in winter and gradual (-2.4 to -2.7) in summer. It also found an annual variation at mid latitude in southern hemisphere, which behaves differently from northern hemisphere, showing a latitudinal drift of the region southward (from 20S to 60S) from May through October. These variations are related with jet stream as described from zonal wind data. We calculated the moving average of z-score value that showed good correlation between temperature variance, spectral slope, and zonal wind.

Keywords: vertical wavenumber spectra, temparature perturbations

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Global Structure of Brunt Vaisala Frequency as revealed COSMIC GPS Radio Occultation

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COSMIC GPS RO data were utilized to investigate the atmospheric stability through deriving Brunt Vaisala frequency (N^2) from temperature profiles. N^2 is calculated using 100 m height difference and averaged into 1 km resolution. Height versus latitude section of N^2 showed the sharpness of tropopause layer. It depicted a very stable condition of the stratosphere layer. The deviation of N^2 in the equator region pronounced clearly relation with QBO phase. Time variations of the structure of N^2 in the stratosphere of polar region between northern hemisphere (NH) and southern hemisphere (SH) are quiet different. An annual oscillation is described in the SH showing the polar night jet during winter season, whereas in winter season of NH the atmospheric stability are influenced by sudden stratosphere warming. An annual oscillation is also depicted in the equator region through time versus longitude diagram of N^2 at 17 km that represent the fluctuation of tropopause layer. Time longitude diagram over 30N latitude at 15 km for the global region showed eastward propagation of atmospheric waves.

Keywords: Brunt Vaisala frequency, COSMIC, GPS RO